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Provisional specification in connection with Application No. 2002950897 for a
patent by MARS INCORPORATED as filed on 16 August 2002.

WITNESS my hand this
Twenty-seventh day of August 2003

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ORIGINAL

PROVISIONAL SPECIFICATION

Invention title: Shelf-Stable Meat Analogues

The invention is described in the following statement:

SHELF-STABLE MEAT ANALOGUES

Field of the Invention

The present invention broadly relates to the manufacture of edible proteinaceous products, in particular texturised protein products (TPPs) for human and/or animal consumption. In particular, the invention relates to a shelf-stable TPP of intermediate moisture and a method and apparatus for the manufacture of same.

10 Background of the Invention

The industrial manufacture of meat analogue products from protein-rich precursor materials, including plant based precursors such as cereal grain gluten (of wheat, rice, or maize; vital or with residual starch), defatted oil seed, cereal and bean flours, meals and derivatives (e.g. defatted soy flour, soy protein concentrates, wheat flour), or animal based precursors such as meat by-products obtained by mechanical separation, fish meal, dried egg white powder and others, alone or in combination, is nowadays well established practice. Cooking-extrusion technology is by far the most widely used one of different possible manufacturing methods to obtain such meat analogues.

20 The general state of the prior art with respect to such products and processes for their manufacture is surveyed in detail in WO 00/69276, by Effem Foods Pty Ltd. This document describes a method of manufacturing a texturised protein product that mimics the appearance of flaked fish meat, shredded chicken meat or other meat products, as well as an apparatus for manufacturing such product. In particular, the document also discloses a suitable formulation for a texturised protein product that enables the TPP to be formed in a high moisture, extrusion cooking process, and to be mechanically shredded into flakes that closely resemble in texture and structure a meat product, such as flaked fish meat or shredded chicken meat.

30 However, the technology disclosed in WO 00/69276 does not provide a TPP that is suitable for all desirable applications. For example, it would be desirable to include such "visually authentic" pieces as a direct inclusion in 'dry' or

semi-moist packeted pet foods (as compared to moist, canned pet foods), in order to reinforce the impression that the product contains 'real' fish or chicken. The relatively high moisture levels of the product disclosed in WO 00/69276 would prevent direct inclusion of such TPP products, as they would impart a limited shelf life to the overall product, thus making them commercially less feasible. Inclusion of such TPP products in an unsterilised, packeted environment would be likely to develop spoilage via mould or other spoilage organisms within a few hours of manufacture. In order to be commercially feasible, the shelf life of packeted products, which are usually not retorted (ie sterilized), need to be at least nine months, and preferably 12 months, thus making the inclusion of high-moisture TPP difficult to achieve.

An obvious solution to this problem would be to dry the TPP in order to decrease its water activity to <0.8 in order to significantly reduce the activity of spoilage organisms. However, this would significantly increase the hardness of the TPP and would thereby greatly decrease its acceptability to the consumer.

Reformulation of the TPP may be undertaken in order to reduce water activity, such as by increasing the cereal content. However, such reformulations will tend to have deleterious effects on the texture and palatability of the TPP, and may also adversely affect the ability of processing equipment to effectively produce the TPP in the desired form. For example, general decreases in formulated moisture levels will lead to greater work being done by the extruder screw as the material passes through it. This results in greater heat development in the material, which may lead to expansion, or 'puffing' of the product. As this would tend to ruin the non-expanded, striated, meat-like appearance intended, such a solution is not desirable.

A common way to reduce water activity while maintaining product texture is to incorporate one or more humectant materials in the formulation. However, for the type of product described in WO 00/69276, i.e. high-moisture extruded TPP, it has been found that many of the common humectant systems do not provide a solution to the problem. In trialling the incorporation of sugars at 12% w/w of the formulation, as used in other semi-moist pet foods, tended to cause blockages and product burning in the high-shear twin-screw extruders necessary for the

manufacture of this type of product.

Alternatively, use of a lower viscosity humectant material, such as a sugar solution, resulted in an inability of the process to provide the correct texture for the product. This is expected, as lower viscosity / higher fluid content feedstocks typically do not produce a textured extrudate, especially in this type of extrusion. Other liquid humectants, such as propylene glycol, are available for extending the shelf life of such TPP products. However, these materials also tend to compromise the texture of the product when added at the levels necessary to produce the shelf-life extension sought. Furthermore, propylene glycol is not suitable for TPP that is to be fed to felines, as it is toxic for such animals and additionally carries a flavour taint that is undesirable.

Therefore, it is an object of the invention is to provide a TPP having visual and textual properties similar to those described in WO 00/69276, but with a significantly extended shelf-life, such that it does not require further sterilisation processing. It is another object of the invention to provide a process for the manufacture of same.

Summary of the Invention

Accordingly, in a first aspect of the present invention, there is provided a method of manufacturing a texturised proteinaceous meat analogue product, having a water activity of lower than about 0.8, said method including:

- subjecting, in a food-extruder, a mixture containing:
 - about 20 to 80% by weight edible proteinaceous materials selected from the group consisting of predetermined mixtures of defatted soy flour, soy meal, soy concentrate, cereal gluten (in vital or starch-containing form) and egg white powder;
 - up to about 5% by weight of edible mineral binding and cross-linking compounds; and
 - up to about 50% by weight of an edible humectant system consisting of a mixture of glycerol and glucose of predetermined ratio;

to mechanical pressure and added heat sufficient to convert the mixture into a hot, viscous protein lava;

- extruding the protein lava through and from a temperature controlled cooling die which cools and increases the viscosity of the protein lava to obtain a cohesive, texturised, extrudate slab or ribbon in which vapour-flashing is substantially inhibited; and

- 5 • subjecting the solidified extrudate slab or ribbon to suitable size-reduction techniques for producing extrudate shreds that resemble in consistency and texture flaked or shredded meat.

Preferably, the product contains about 25% by weight glycerol and about 5% by weight of glucose. The presence of these humectants allows the TPP to
10 maintain a texture that is soft enough to be acceptable to the consumer, while reducing the water activity to a level that allows a shelf life of at least 12 months in ambient conditions. Unexpectedly, this combination of liquid humectant ingredients does not produce a deleterious effect on product texture or on the ability of the equipment to successfully process the materials. The water activity
15 of the final product can be advantageously set to between about 0.55 and about 0.68.

Preferably, the size reduction is performed by shredding in a hammer mill having a cage plate with a plurality of elongate discharge openings and a plurality of hammer bars hinged to discs attached to a rotating shaft.

20 Preferably, the temperature of the product components in the extruder is minimised by using a twin-screw extruder with five barrel sections and a screw speed in the range 300rpm to 550rpm, and even more preferably about 500rpm. The temperature of the molten lava is preferably restricted to $<120^{\circ}\text{C}$.

Use of the hammer mill modified in accordance with the invention enables
25 the manufacture of extrudate shreds that resemble, in consistency and texture, flaked fish meat, shredded chicken meat or shredded red meat (such as beef or lamb).

In performing the above method, addition of some real meat product or meat by-product into the TPP mass is an optional step to enhance flavor and to
30 provide animal protein contents. This addition may occur prior to, during or after the step of subjecting the mixture to mechanical pressure and heat. Preferably, the addition of the meat product or meat by-product occurs during the extrusion

step. This real meat or meat by product may be obtained from fish, poultry or from livestock (such as cattle or sheep).

Advantageously, the extrudate is transferred directly after leaving the cooling die to the hammer mill for shredding, as optimum shredding to obtain extrudate shreds or flakes is achieved whilst the extrudate slab is still warm. Therefore, typically, the time between extrusion and cutting should not exceed 5 minutes.

Preferably, the mixture referred to above has total moisture content of between about 15 and about 40%.

It will be understood that the extrudate can be conveyed as a continuous band or ribbon directly into the hammer mill, or it may be conveyed in shorter lengths or discontinuous portions.

A preferred formulation, which results in extrudate shreds that substantially mimic tuna fish flakes and which can be blended directly into a packeted pet food product, consists of:

- a dry ingredient mixture, making up about 50% of extrudate mass, consisting of about 40% defatted soy flour, about 40% vital wheat gluten, about 0.5% nutritional vitamin supplements, about 8.5% mineral supplements, about 2.0% flavouring agents, about 4.3% colouring agents and about 4.7% carbohydrate (all weight %);
- a humectant blend, making up about 30% of extrudate mass, consisting of about 83% glycerol and about 17% glucose; and
- injected meat material, making up about 20% of extrudate mass, consisting of comminuted material derived from chicken, fish or livestock.

As disclosed in WO 00/69276, a conventional hammer mill, which is generally employed to grind, particulate or pulverise dry, relatively hard materials such as coal, grains, seeds and similar dry materials, can be employed with a modified screen in accordance with this aspect of the invention to shred the proteinaceous, plasto-elastically-resilient, and moisture-rich extrudate slab or ribbon into chunks or pieces that closely resemble in appearance those of shredded tuna fish meat or chicken meat, without otherwise adversely affecting the structure and texturisation of the TPP shreds.

In a second aspect of the present invention there is provided a shredded meat analogue product manufactured in accordance with any one of the processes described above using the formulation of materials referred to above.

The cooling die may be adapted so as to form the extrudate slab or ribbon
5 having any suitable cross-section (e.g. rectangular or circular).

The production line is arranged such that continuous manufacturing of shredded TPP extrudate is achieved from metering of the dry ingredients and water into the extruder to metering the extrudate shreds into appropriate vessels for further processing. Alternatively, a further conveyor means can be disposed
10 underneath the hammer mill discharge chute for conveying the meat analogue shreds towards further processing units of an integrated food production line, (e.g. a canning station or the like).

In a further refinement, it has been found to be particularly advantageous in conducting the manufacturing process to employ a modified twin conveyor and
15 pressurising screw extruder with 4 to 6 barrel sections that are individually temperature controlled, each section having a length to diameter ratio of approximately 4, as used in high moisture extrusion cooking. Temperature settings at the individual barrel sections during the manufacturing process will vary between 60 and 150°C and internal pressure between 3 and 8 MPa, at
20 screw speeds of between 300 to 550 rpm.

Further features and advantages of the invention will be described in the following in relation to preferred embodiments thereof by way of non-limiting examples.

25 DESCRIPTION OF PREFERRED EMBODIMENT

The following non-limiting description of a preferred embodiment of the invention is presented with reference to the TPP product, and the manufacturing processes and equipment therefor, as described in detail in WO 00/69276.

A TPP product having a fibrous striated structural matrix and resembling
30 tuna white meat was prepared generally according to the process and formulation details given in Example 2 in the preferred embodiment description of WO 00/69276, except with the changes to formulation and process conditions outlined

as follows:

The ingredients listed in Table 1 were weighed out as indicated there, milled through a hammer mill fitted with a screen of size 1.2 - 2 mm and pre-blended in a ribbon blender for 4 minutes.

5

Table 1

	<u>Ingredient</u>	<u>% by weight</u>
	Defatted soy flour	40
	Vital wheat gluten	40
	Vitamins	0.5
10	Minerals	8.5
	Carbohydrate	4.7
	Flavouring agents	2.0
	Colouring agents	4.3

15 Added to this mix was a blend of humectants, consisting of 83% glycerol by weight and 17 % glucose by weight. This blended mixture was then fed into the hopper and metered into the extruder (Werner & Pfleiderer C58, fitted with 5 barrel sections) at a rate of 138kg/hr. Comminuted tuna-derived material was injected into the molten material at a rate such that the overall mass-flow ratio of
 20 dry material:humectants:tuna material was approximately 5:3:2. The extruder screw speed was set at 530rpm. Temperatures of the barrels were regulated to the values listed in Table 2.

Table 2

	<u>Barrel number</u>	<u>Temp °C</u>
25	1	20
	2	50-60
	3	70-80
	4	100-110
	5	110-120

30 The dry precursor materials are plasticised and molten into a viscous extrudate as they are conveyed through the extruder barrel sections. The hot melt is extruded through the breaker plate. The extrudate leaving the breaker plate

enters the cooling die channel member (cross-sectional dimensions of 50 mm by 7 mm and a length of 400 mm), cooling water inlet temperature being set at about 5°C.

5 Extrudate product exiting the cooling die as a continuous slab was analysed and shown to have a moisture level of 25% by weight and a water activity of 0.68. The slab was then conveyed directly to the modified hammer mill. The product slab was cut and shredded into pieces of torn, non-uniform appearance, quite similar to canned white tuna pieces. The rotational speed of the hammer discs was set to 1800 - 2000 rpm, whilst a screen with holes of a size
10 of 50 mm by 7 mm was employed.

The shredded pieces obtained had an appearance similar to that of shredded tuna meat. This material has a shelf life in excess of 12 months in ambient conditions.

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